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The Gaseous Electronics Conference Radio-Frequency Reference Cell

Preface

One of the most important commercial applications of low-temperature, radio-frequency (rf) glow discharges is the fabrication of microelectronic circuitry. However, many plasma-based production processes suffer from reliability problems. A process may work well for some time and then fail mysteriously, or a process may yield certain results in one plasma reactor, and completely different results in another. These types of uncertainties in process and reactor performance cause decreased manufacturing efficiency, increased costs, and limit the development of increasingly complex semiconductor devices.

The unpredictability of semiconductor fabrication processes has been attributed to subtle differences in reactor conditions that could not easily be detected, such as feed gas impurities, surface conditioning, surface charging, and minor variations in electrical circuits. However, progress in isolating the effects of these conditions was slowed by the fact that the plasma reactors used by many researchers were so vastly different in design from one another, that differences in experimental data due to reactor conditions could not be separated from the effects of different reactor geometries.

An attempt to formally address this problem at the 1988 Gaseous Electronics Conference (GEC) resulted in the design of the GEC RF Reference Cell: a parallel plate, capacitively-coupled, rf plasma reactor that, in principle, is suitable for studies of basic discharge phenomena, investigation of industrial-type plasmas, and theoretical modeling. The use of several of these chambers to perform similar experiments in different laboratories, with subsequent comparison of results, was proposed to isolate the effects of reactor geometry from other experimental variables. Over the years, the number of GEC Cells has increased from 6 to 25, and they are now found in 19 different laboratories throughout the United States and Europe. Work performed on GEC Cells has resulted in the publication of over 75 articles and reports, and has been presented at numerous conferences.

At the 1993 Gaseous Electronics Conference, it was determined that a sufficient amount of research had been performed on GEC Cells that a review of the available data would be useful, and so it was decided that a Special Issue of the *Journal of Research of the National Institute of Standards and Technology* would be dedicated to work performed on GEC RF Reference Cells. Submission of articles to this Special Issue corresponded to the hosting of the 1994 Gaseous Electronics Conference by NIST. The issue before you is the result of that decision. This issue contains 12 articles that review nearly all of the experiments and theoretical modeling efforts that have been performed over the last 5 years using GEC Cells. While the emphasis of these articles is on the comparison of data obtained on different GEC Cells, together they serve as a "users' guide" to the operation and performance of the GEC Cell. Hopefully, this makes this issue useful to both novices and experts in the plasma processing community.

All of the articles in this issue have been reviewed, and I am grateful to the many scientists at NIST and elsewhere who served as referees. I also wish to thank Julian Ives for his invaluable assistance in the production of this Special Issue.

James K. Olthoff
Editor